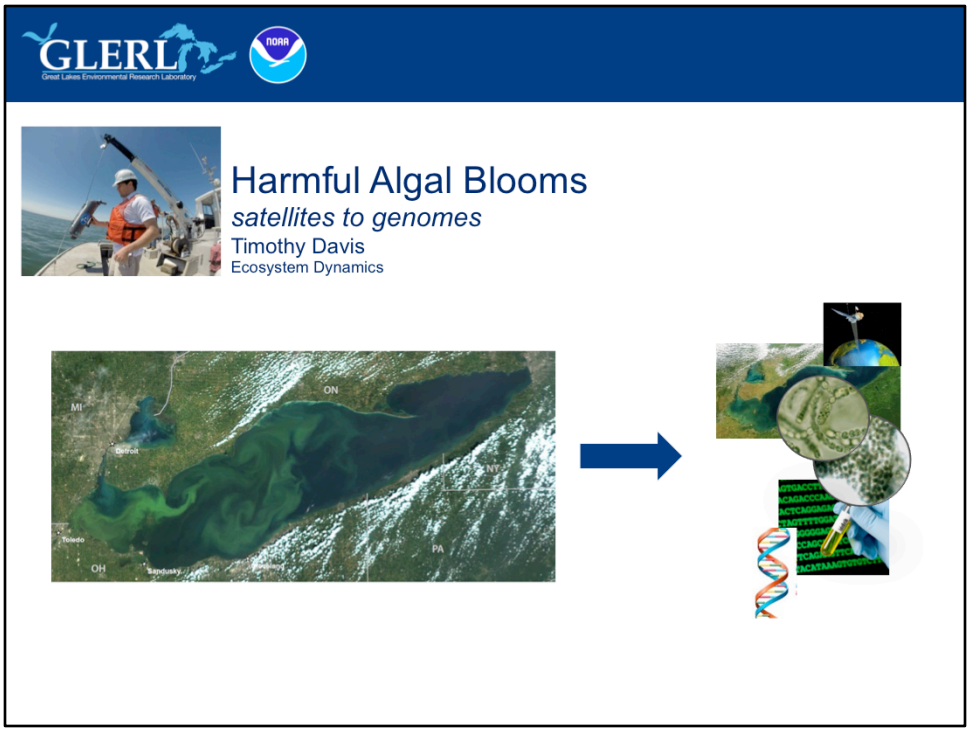


This work aligns with the following NOAA Goals:

Science: Climate Adaptation and Mitigation

Assessments of current and future states of the climate system that identify potential impacts and inform science, service, and stewardship decisions

Mitigation and adaptation efforts supported by sustained, reliable, and timely climate services

Science: Weather-Ready Nation

Reduced loss of life, property, and disruption from high-impact events

Improve freshwater resource management

Improve transportation efficiency and safety

Healthy people and communities due to improved air and water quality services

A more productive and efficient economy through information relevant to key sectors of the U.S. economy

Science: Healthy Oceans

Improved understanding of ecosystems to inform resource management decisions

Healthy habitats that sustain resilient and thriving marine resources and communities

Sustainable fisheries and safe seafood for healthy populations and vibrant communities

Science: Resilient Coastal Communities and Economies

Resilient coastal communities that can adapt to the impacts of hazards and climate change

Improved coastal water quality supporting human health and coastal ecosystem services

Safe, environmentally sound Arctic access and resource management

Education: Science-Informed Society

Youth and adults from all backgrounds improve their understanding of NOAA-related sciences by participating in education and outreach opportunities

Formal and informal educators integrate NOAA-related sciences into their curricula, practices, and programs

Formal and informal education organizations integrate NOAA-related science content and collaborate with NOAA scientists on the development of exhibits, media, materials, and programs that support NOAA's mission

Education: Safety and Preparedness

Youth and adults from all backgrounds are aware of, prepare for, and appropriately respond to environmental hazards that impact health, safety, and the economy in their communities

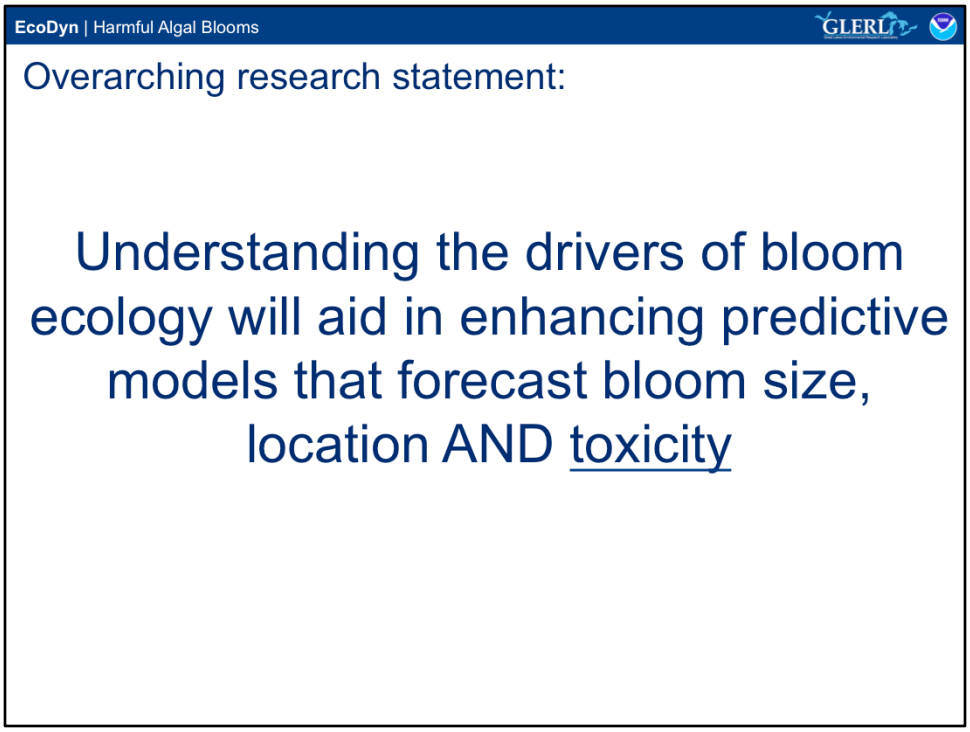
Formal and informal educators use and produce education materials and programs that integrate and promote consistent science-based messaging on hazards, impacts, and societal challenges related to water, weather, and climate

Formal and informal education institutions integrate water, weather, and climate hazard awareness, preparedness, and response information into curricula, exhibits, and programs that create learning opportunities for youth and adults

Education: Future Workforce

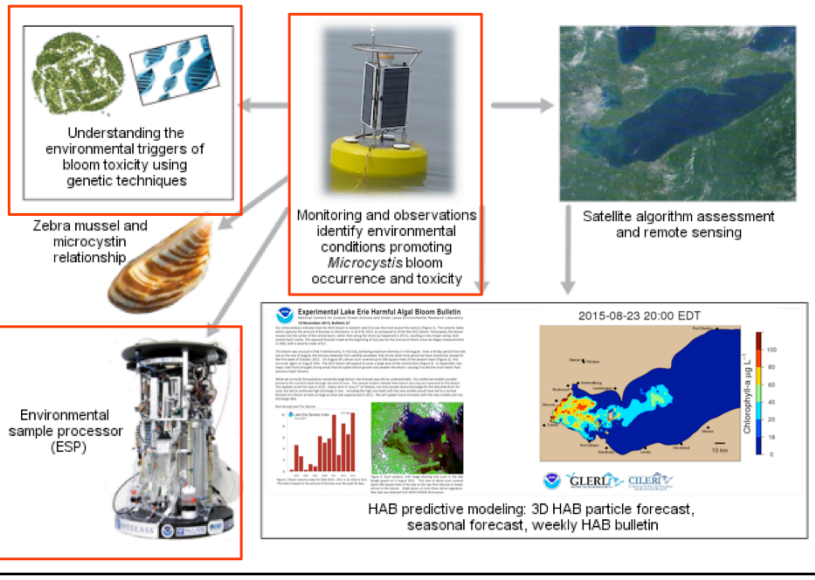
Postsecondary students, particularly from underrepresented groups, pursue and complete degrees in disciplines critical to NOAA's mission

Graduates completing NOAA-supported student opportunities continue education, enter the workforce, and advance in careers that support NOAA's mission



Overarching research statement:
Understanding the drivers of bloom ecology will aid in enhancing predictive models that forecast bloom size, location AND toxicity

An integrated approach to studying HABs



GLERL's cross-branch HAB Team

Monitoring & Experiments
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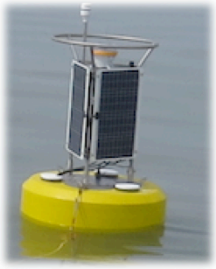
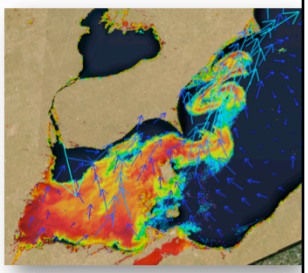
Ashley Burtner*
Danna Palladino*
Heidi Purcell*
Hank Vanderploeg
Alicia Ritzenthaler*





Remote Sensing
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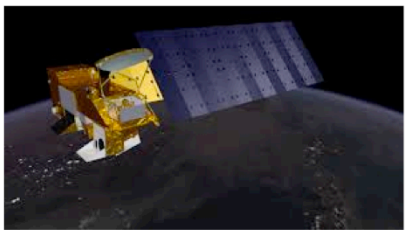
Ron Muzzi
Russ Miller

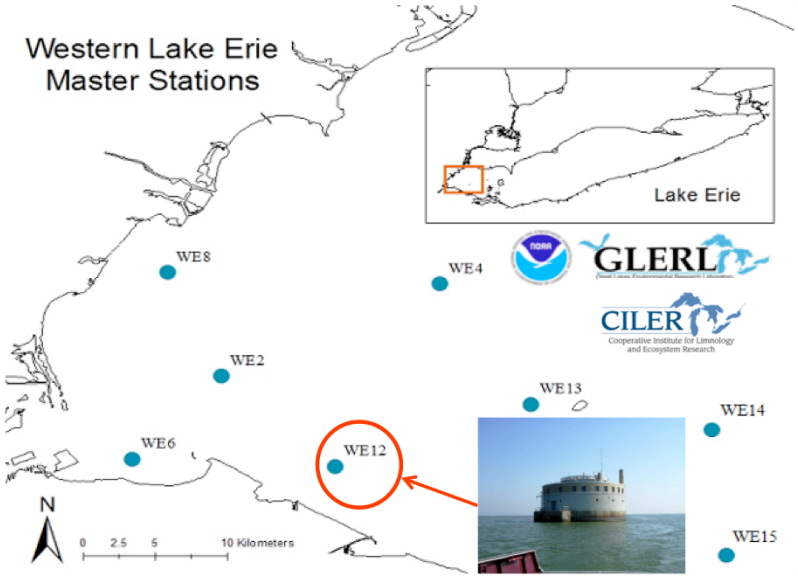


Modeling
Eric Anderson
Mark Rowe*
Greg Lang

Communications
Sonia Joseph Joshi*
Joe Smith*

BOLD = HAB team leads
*** = CILER employees**

Western Lake Erie weekly sampling



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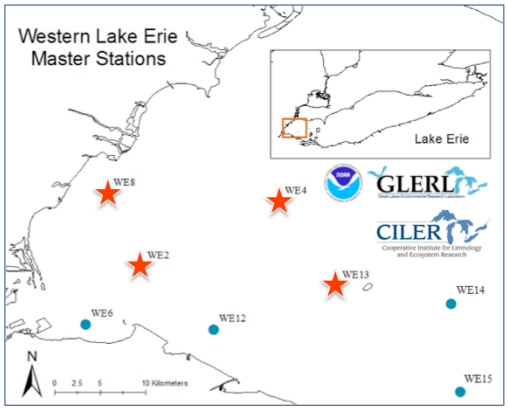
Western Lake Erie real-time HABs monitoring

Sensors:

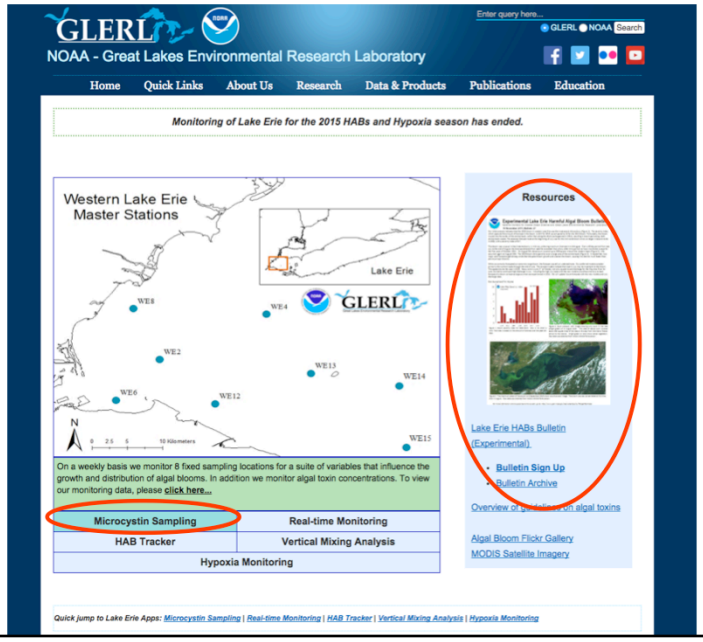
- Turner C6, Cyclops sensors
- YSI EXO sondes
- Chlorophyll, Phycocyanin, Turbidity, CDOM

- Wetlabs Cycle -PO_4

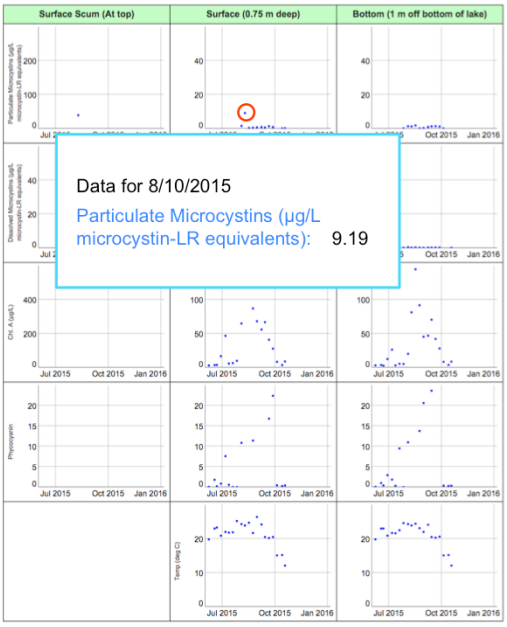


= Real-time observation station in 2015

NOAA GLERL HAB webpage



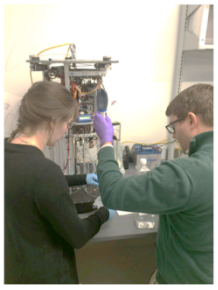
Critical water quality data provided to stakeholders



- Weekly data shared with over 30 regional partners
- Allows stakeholders to view trends in bloom biomass and toxicity
- Surface and bottom measurements

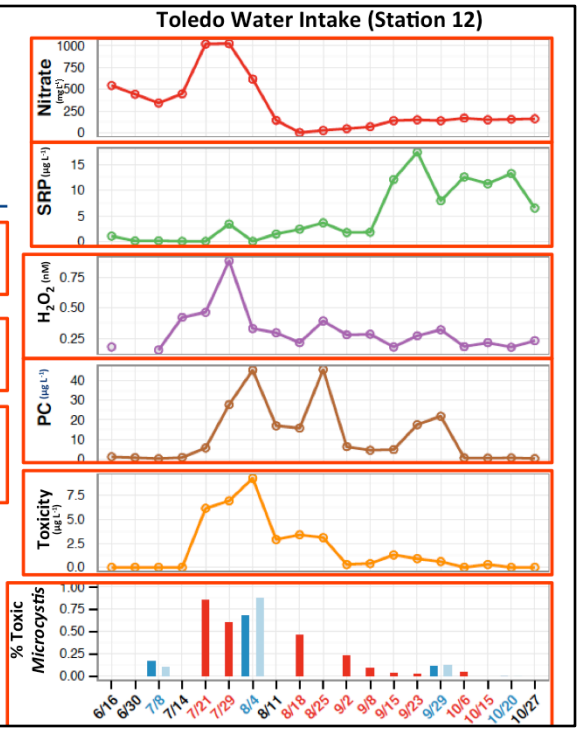
Autonomous near real-time toxin detection for Lake Erie

- FY14 EPA-Great Lakes Restoration Initiative supplemental funds
- First ESP to be deployed in the Great Lakes
- Cross line office collaboration (GLERL/National Ocean Service)
- Would be able to track blooms toxicity at a resolution that was previously unattainable with traditional sampling
- Will be referenced against physical, chemical and biological conditions
- **Will be extremely valuable in the development of more accurate bloom forecasting products**



Weekly sampling reveals important trends that highlight potential environmental drivers and inform future experiments

- Toxicity changes throughout the bloom
- Relationship between nitrogen, toxicity and toxic *Microcystis*
- *Microcystis* blooms occur even when phosphorus concentrations are low
- Other factors beyond nutrients may be important in driving bloom structure and function



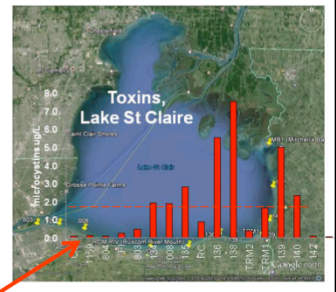
Nutrients and Harmful Cyanobacterial Blooms

Combined field & molecular approaches to:

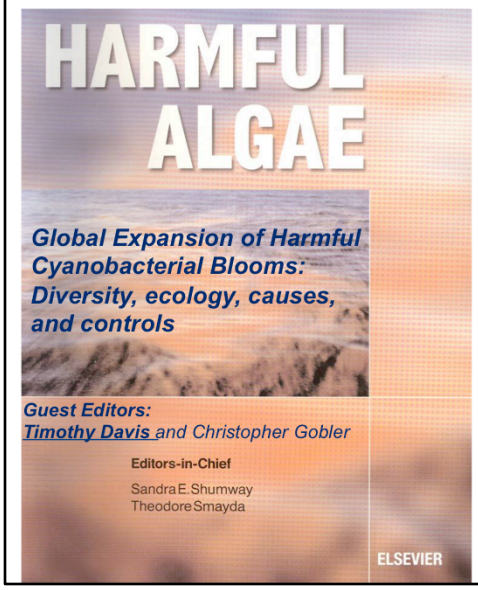
- Origins & toxicity of cHAB species in relation to nutrients, physical processes & climate
- Factors controlling toxin gene abundance & expression
- diversity of toxic cHAB species & resilience to climate change
- models for predicting bloom toxicity

– *Results have clear implications for management:*

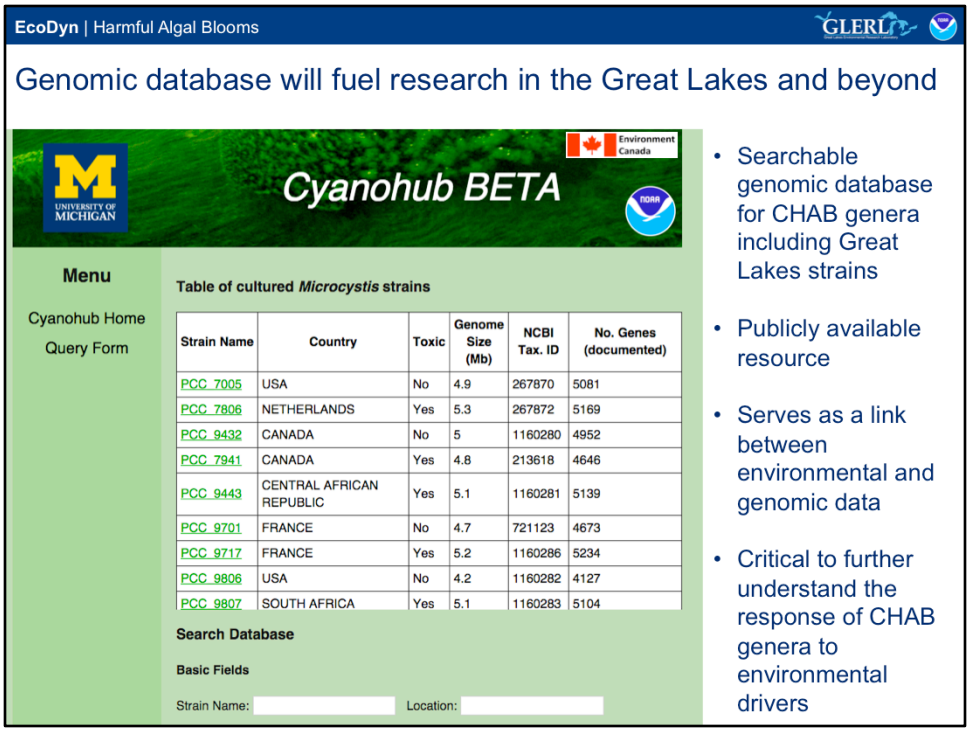
- direct ***influence of tributaries*** (Thames R) on toxin levels.
- Genomics: identical HAB strains across LSC-Lake Erie-Lake Ontario ***i.e. widespread potential for HABs, enabled by anthropogenic stressors***
- Significant ***positive effect of N*** on growth and toxin production in open Lake Erie and tributaries (Sandusky Bay)



High-impact publications:



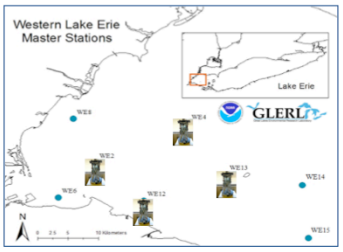
- Harmful Algae
  - 2014 Impact Factor: 3.874
  - 5-year impact factor 3.765
- 15 manuscripts on genera, ecology, drinking water, human health, toxin and taste and odor, grazing and synthesis review
- Research from Europe, USA, Australia, China, South America
- This issue features the work of:
  - 5 NOAA researchers
  - 3 CILER researchers
- In print in April 2016

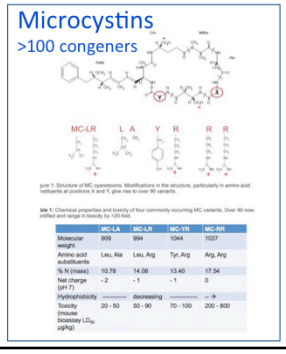


Great Lakes cyanobacterial cultures and experiments

Future directions and challenges

- Develop an ESP network for Western Lake Erie
- Further develop the ESP capabilities
- Investigate the ecological adaptations of Great Lakes CHAB species
- Further understanding the interactive roles of light, nutrients, and temperature on toxin production and community composition
- Investigate changes in microcystin congeners over time





ESP: sandwich hybridization assay, microfluidic block for qPCR, multiplex toxin assay (microcystins + saxitoxins)

Microcystis blooms (Western Basin Lake Erie, Lake St. Clair, Green Bay, Hamilton Harbor) *Anabanea* blooms (Cleveland area & Western Basin of LE, Bay of Quinte) and *Planktothrix* blooms in Sandusky Bay

This would involve investigating the molecular response of these phytoplankton to different environmental variables (light, nutrient, temperature, CO_2) on a global level (comparative genomic/transcriptomic studies)

Questions?